Spectral-Domain Optical Coherence Tomography Versus Ultrasound Biomicroscopy for Imaging of Nonpigmented Iris Tumors

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• PURPOSE: To evaluate the use of spectral-domain optical coherence tomography (SDOCT) for imaging of nonpigmented iris tumors, through its comparison with ultrasound biomicroscopy (UBM).
• DESIGN: Retrospective observational case series.
• METHODS: Consecutive patients with non-pigmented iris tumors, not extending to the ciliary body, who were concurrently evaluated with SD-OCT and UBM were included. Demographics, anterior segment clinical photographs, images obtained with SD-OCT (Cirrus HD-OCT, Zeiss Meditec, Dublin, California, USA) with 5.1.1 anterior segment software upgrade, and UBM (Humphrey Instruments, San Leandro, California, USA) were reviewed. The images produced were compared regarding the degree of anterior and posterior tumor surface resolution, internal structures, tumor thickness measurement, image artefacts, and overall tumor visualization.
• RESULTS: Thirty-seven patients with nonpigmented iris tumors were included. Comparing SDOCT to UBM, the image definitions of anterior tumor surface and internal tumor heterogeneity were equivalent. Posterior tumor surface was well defined in 54% of SDOCT vs 100% in UBM images. Full tumor thickness measurement was possible in 86% of SDOCT vs 100% with UBM. The maximum measurable tumor thickness with SDOCT was 1.34 mm. SDOCT images showed optical aberrations such as shadowing and ghost images in 22 tumors (59%), which encroached on the tumor image in 8 patients (22%). The overall tumor visualization with SDOCT was possible in 65% of the iris tumors.
• CONCLUSIONS: UBM generally provides superior imaging quality and reproducible measurements of nonpigmented iris tumors. Nevertheless, SDOCT, being a noncontact technique, can be a reliable alternative in imaging and following some selected nonpigmented iris tumors. (Am J Ophthalmol 2013;156:806–812.

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ULTRASOUND BIOMICROSCOPY (UBM) HAS BEEN the method of choice for imaging anterior segment lesions, since it can produce high-resolution images superior to those previously obtained through B-scan ultrasonography with immersion technique. In case of iris tumors, UBM enables visualization of tumor boundaries, internal structures, ciliary body involvement, and impact on surrounding structures; it can also provide accurate metrics of tumor dimensions.[1–4]

The advent of optical coherence tomography (OCT) permitted in vivo high-definition imaging of the retinal layers that permitted better visualization of retinal pathology.[5] The more recent spectral-domain OCT (SDOCT) provides higher signal-to-noise ratio and fewer motion artefacts, and is less time consuming than the older time-domain OCT (TDOCT) technology.[6,7] Cirrus OCT (Carl Zeiss Meditec, Dublin, California, USA) is an SDOCT that became widely used in many ophthalmology centers to image fundus lesions. This instrument can also image anterior segment structures with the aid of an upgrade addendum to the operating software, providing an alternative to the less prevalent, anterior segment–specific TDOCT systems.[8–12]

The comparison between OCT and UBM in imaging anterior segment has been previously reported. However, in those reports, the anterior segment TDOCT was evaluated vs UBM, and the included anterior segment lesions were pigmented and nonpigmented. The results of those studies demonstrated the limited capacity of the OCT light energy to penetrate through the pigmented tissue, which disadvantaged OCT as an imaging technique for pigmented anterior segment tumors.[13–18]

In this report, we investigate the potentials and limitations of anterior segment imaging with OCT in the nonpigmented tumors, localized to the iris, using the more commonly available Cirrus SDOCT. We compare the various aspects of the imaging features of SDOCT vs those of UBM.

PATIENTS AND METHODS

A RETROSPECTIVE REVIEW OF THE ELECTRONIC CHARTS and images of consecutive patients with nonpigmented iris tumors was conducted from June 2008 to November 2011. Iris tumors that extended to the ciliary body, as

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verified with UBM, were excluded. The approvals for retrospective data collection were obtained from the Research Ethics Board of University Health Network, Toronto, Ontario, Canada. We included those patients who were evaluated with both SDOCT and UBM in this institution, in the same examination visit.

UBM was performed using the prototype instrument (Humphrey Instruments, San Leandro, California, USA) with a 50 MHz transducer. The technique required the application of an eyecup filled with 1% methylcellulose as a coupling fluid between the UBM transducer and the eye surface. Images were obtained at the radial meridian through the lesion enclosing the greatest tumor depth and lateral tumor margins in 1 image, whenever feasible. Measurement of tumor depth was obtained using the built-in electronic caliper within the UBM operating software. The UBM image parameters were standard in all patients using an ultrasonographic gain of 80 decibels (db), contrast degree TF1, delay of 2.24 mm, and time-gain control of 5 db/min.

Anterior segment OCT was performed using SDOCT of Cirrus HD-OCT (Carl Zeiss Meditec), model 4000 with 5.1.1 software upgrade. The images were obtained using anterior segment 5-line raster applied on the tumor radial meridian. Each line is 3 mm in length, separated by 250 μm, so that the 5 lines together cover 1 mm width. OCT images were selected to display the apex of the iris tumor and were in the same vertical plane of the corresponding UBM images, for accurate comparison.

Patient data included demographics (age, sex) and iris color. Relevant clinical data included tumor profile (dome, diffuse, irregular), radial location of main tumor mass in iris (pupillary, midzonal, limbal), and anterior surface morphology (smooth, irregular, tapioca-like). Both UBM and OCT were compared with regard to degree of image definition of the anterior and posterior surfaces of the tumor (well-defined, if all clinically visible surface details were clearly imaged; medium, if surface details were partially lost in imaging; ill-defined, if no surface details could be imaged), resolution of internal tumor structures (homogeneous, if no internal structures, such as blood vessels or variations in tissue density, could be visualized; heterogeneous, if internal structures could be detected), and overall tumor visualization (good, if anterior, posterior, and lateral tumor surfaces are clearly imaged; partial, if any of the surfaces is partially lost in imaging; poor, if 1 or more surfaces was completely lost in imaging). Tumor thickness measurement in millimeters was done using the built-in electronic calipers in both UBM and OCT machines. In tumors where the full thickness of the tumor could not be visualized using OCT, the maximum depth of visualization was measured.

Other features of concern that could affect the quality of the generated images producing imaging artefacts included: with UBM, presence of posterior tumor shadowing (present, absent); with OCT, presence of optical aberrations that degraded imaging quality, such as ghost mirror-image reflections or shadowing that encroached on the imaged tumor from a nearby opaque (eg, corneal opacity, ectropion uvae) or translucent structure (eg, the limbus).

RESULTS

IN THIS STUDY, 37 EYES OF 37 PATIENTS WITH NONPIGMENTED iris tumors, not extending to the ciliary body, met the inclusion criteria. Patient median age was 58 years (range 17-83). Patient sex was 12 male (32%) and 25 female (68%). Iris colors were varying degrees of blue in all patients. Tumor profile was dome-shaped in 14 patients (38%), diffuse in 5 (14%), and irregular in18 (48%). Tumor epicenter location was limbal in 9 patients (25%), iris mid-zone in 10 (27%), and pupillary in 18 (48%). The tumor surface morphology appeared smooth in 21 patients (57%), irregular in 14 (38%), and tapioca-like in 2 (5%).

• **IMAGING OF ANTERIOR TUMOR SURFACE:** Both techniques produced high-resolution images of the anterior surface in 100% of the tumors. SDOCT produced better image definition of the anterior surface in 2 tapioca-like and 2 irregular surface tumors, revealing finger-like projections from the tumor surface that could not be detected with UBM (Figure 1, Top).

• **IMAGING OF TUMOR INTERNAL STRUCTURES:** Both techniques detected the presence of internal structural heterogeneity in 9 of 37 tumors (24%) (Figure 1, Middle).

• **IMAGING OF POSTERIOR TUMOR SURFACE:** The posterior surface could be clearly visualized in all tumors with UBM, while in thicker tumors it was partially visible in 12 of the 37 tumors (32%) with SDOCT and completely invisible in 5 (14%) (Figure 1, Bottom).

• **TUMOR THICKNESS MEASUREMENT:** Thickness measurement from the highest point on the anterior surface of the tumor to the posterior was possible in 100% of patients using the UBM built-in calipers. The median tumor thickness was 1.03 mm (range: 0.61-2.47 mm). In the corresponding SDOCT images, the reflected light signals showed gradual attenuation from the anterior tumor surface towards the posterior, before no further reflected light signals could be visualized. The maximum depth of light penetration was 1.08 mm (Figure 2, Top). However, in some tumors thicker than 1.08 mm, a faint reflection from the posterior tumor surface, which represents an optical interface, could be perceived and the full thickness could be measured in those tumors. The maximum measurable tumor thickness with SDOCT in this cohort was